Development of Broadband Light Source for OPCPA

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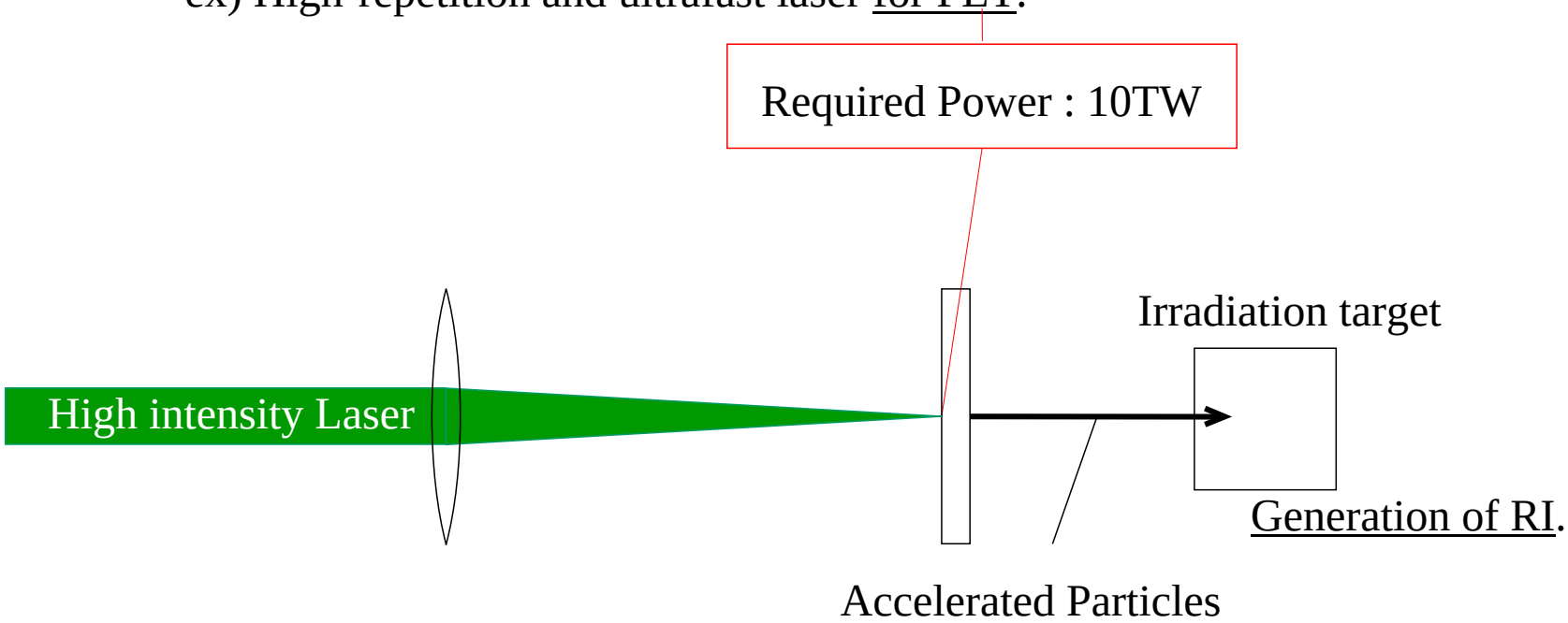
Background

- Development of high-peak power lasers.

  Required for higher field physics

- Femtsecond lasers for various applications.

  ex) High-repetition and ultrafast laser for PET.



Our aim of this experiment

○ Development of high power and ultrafast laser

・A development of tunable femtosecond high-repetition laser by OPCPA

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・Amplification by Optical Parametric Chirped Pulse Amplification (OPCPA).

Broadband amplification by noncollinear phase matching

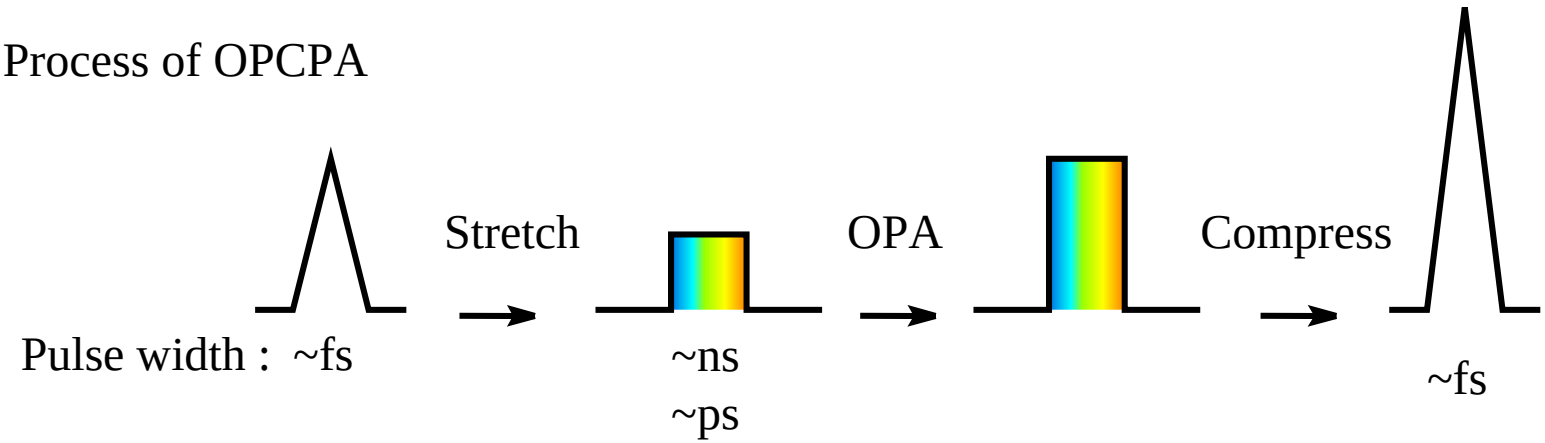
Tunable amplification by changing optic axis

Possibility of high power using large size crystal, like KDP

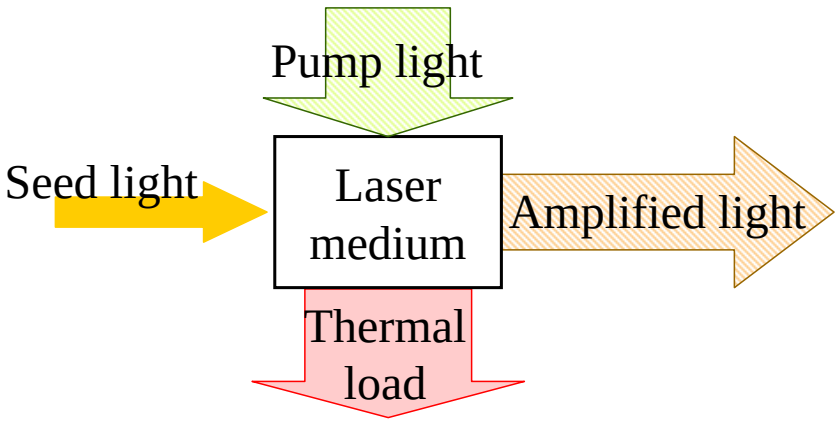
・Generation of supercontinuum by Phonic Crystal Fiber (PCF).

OPCPA : OPA(Optical Parametric Amp.) + CPA(Chirped Pulse Amp.)

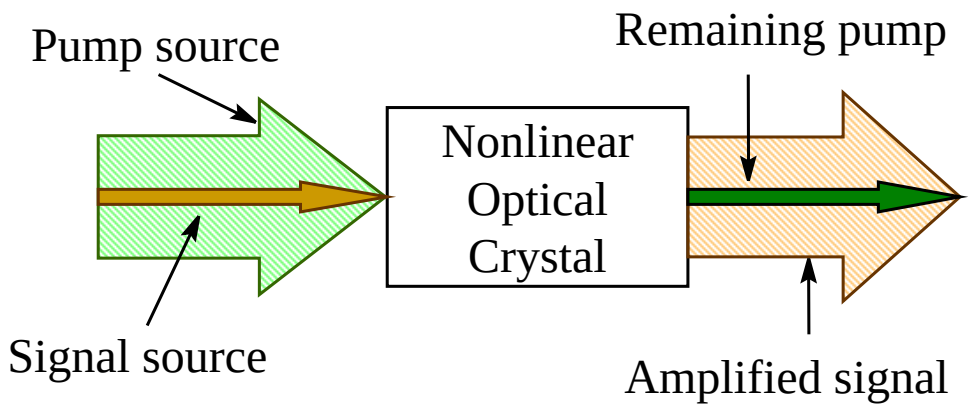
○ Process of OPCPA



・Conventional amplification

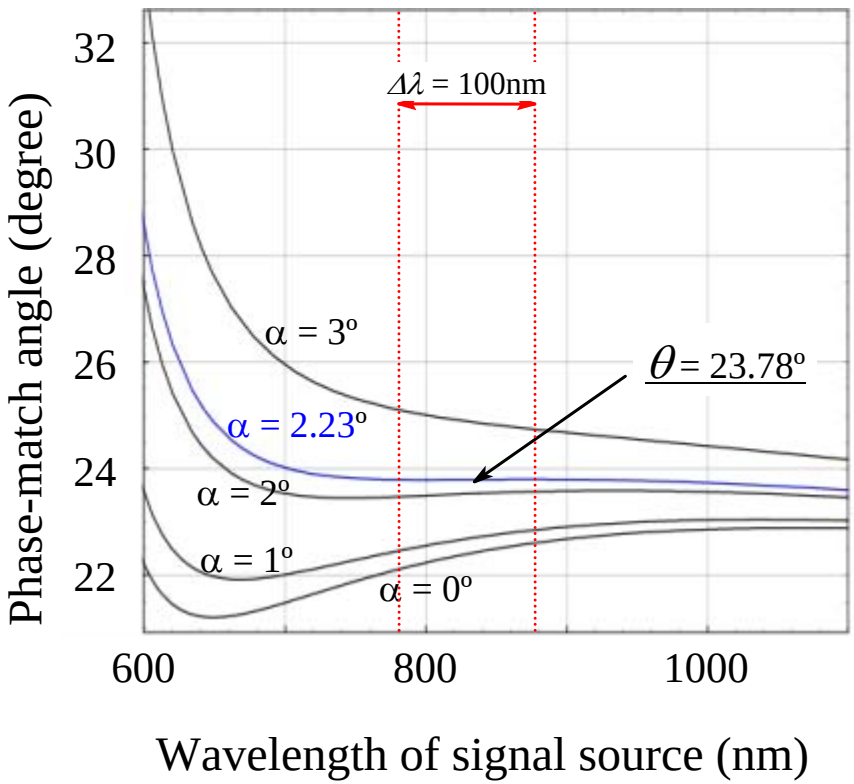


・OPCPA

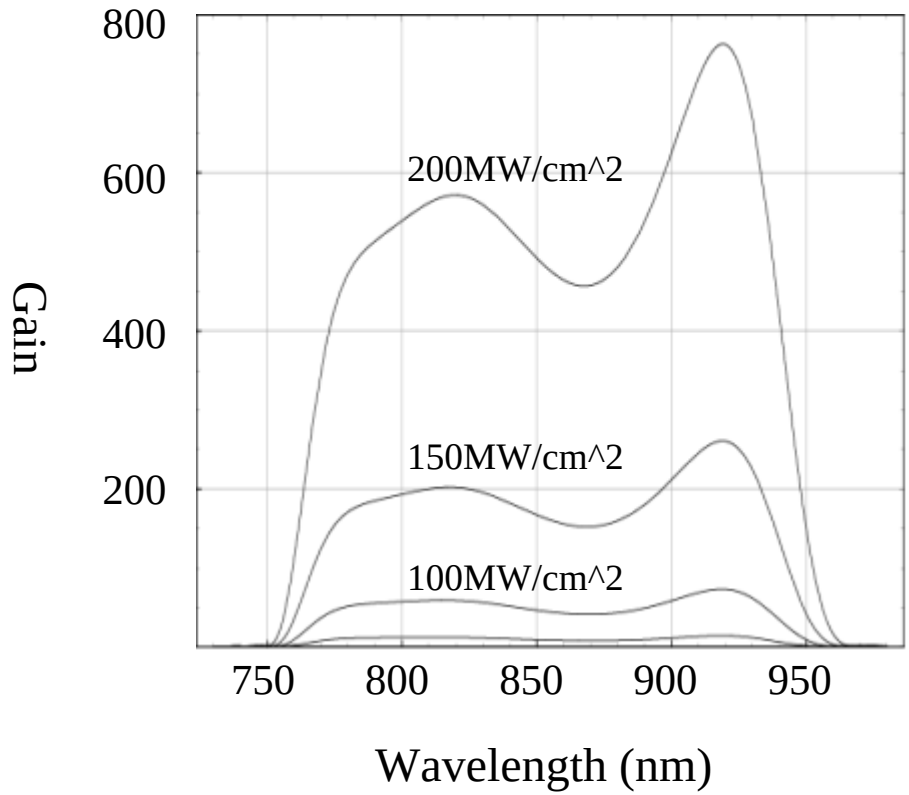


Noncollinear phase matching for a BBO crystal

Phase-matching condition with 532nm pump source



Gain spectrum at $\theta = 23.78^{\circ}$ and $\alpha = 2.23^{\circ}$



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Possibility of high power using large size crystal, like KDP

・Generation of supercontinuum by Phonic Crystal Fiber (PCF).

Generation of supercontinuum in Photonic Crystal Fiber

○ Photonic Crystal Fiber (PCF) ···

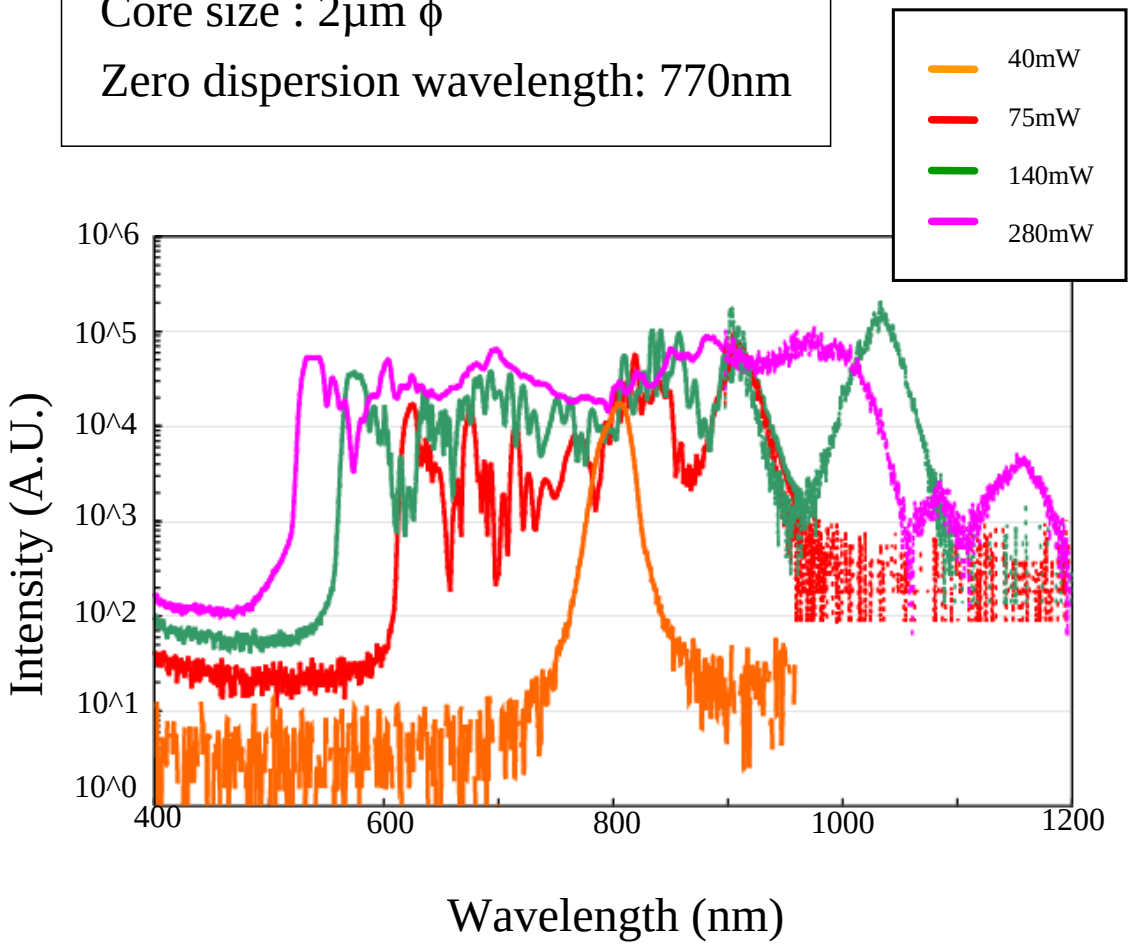
・Small mode field diameter (~μm)

・Large nonlinear effect

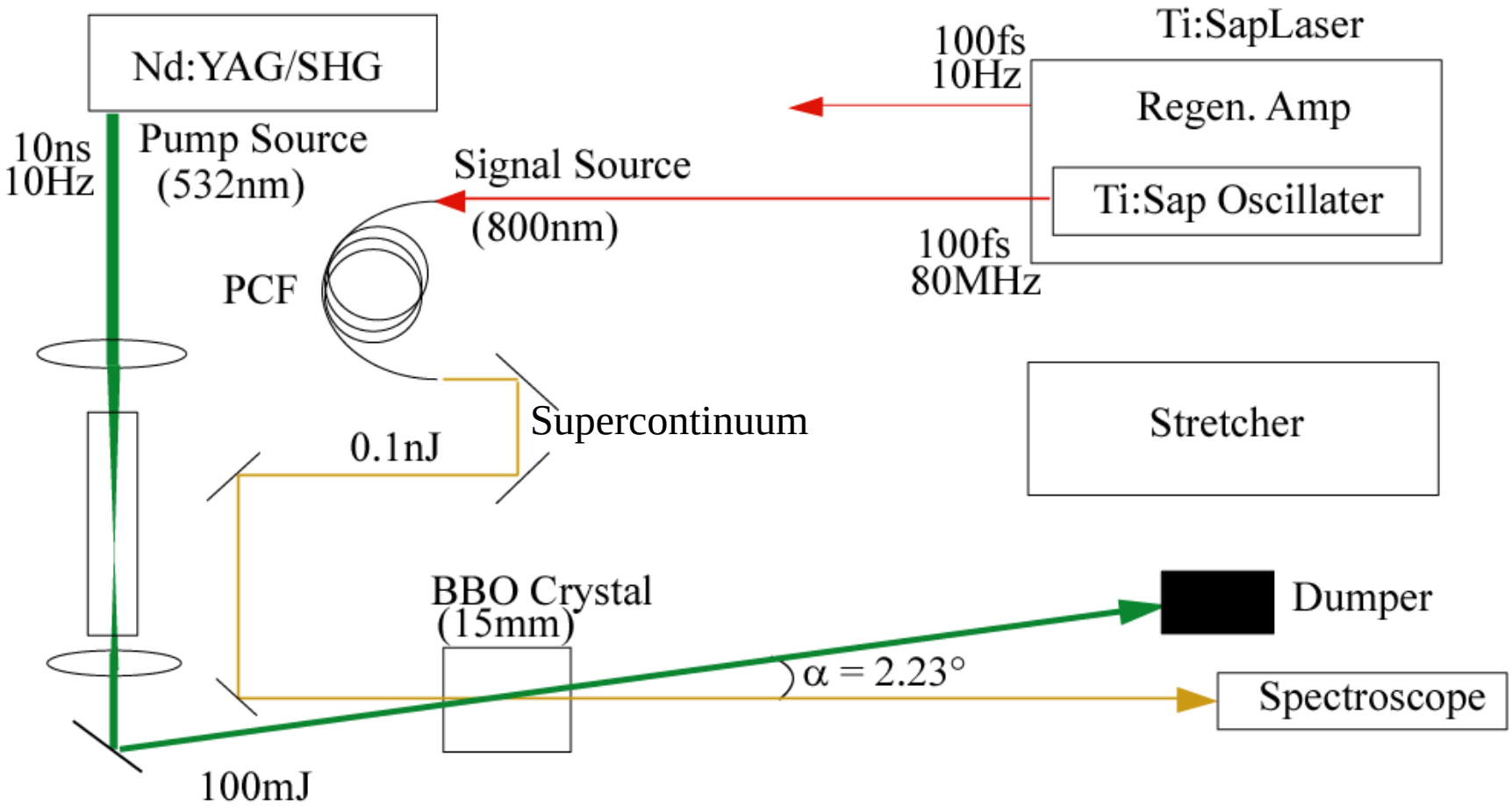
・The zero-dispersion wavelength is controllable

Stable generation of supercontinuum

Light source : 800nm 100fs 80MHz
Core size : 2μm ϕ
Zero dispersion wavelength: 770nm

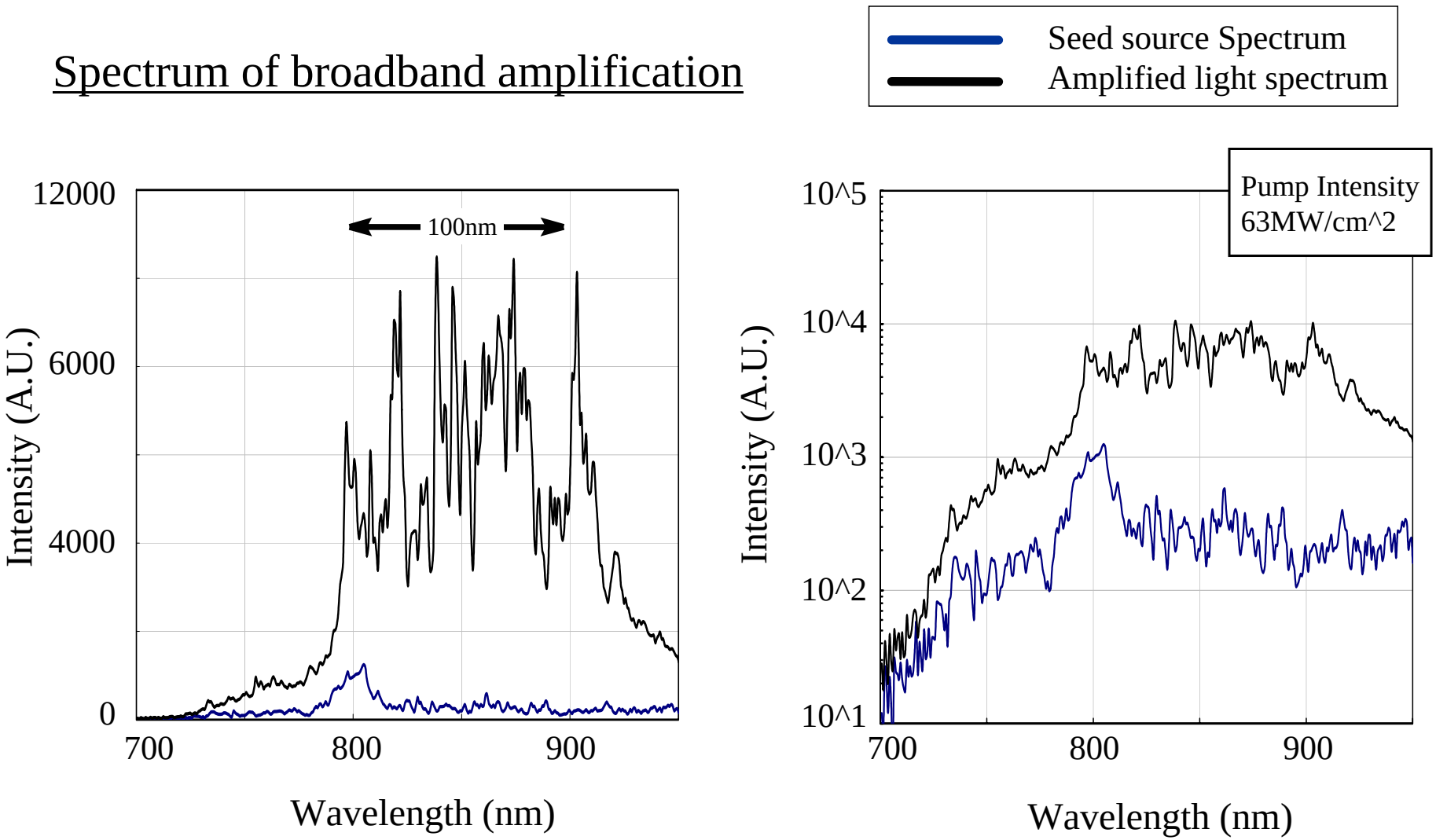


Experimental setup



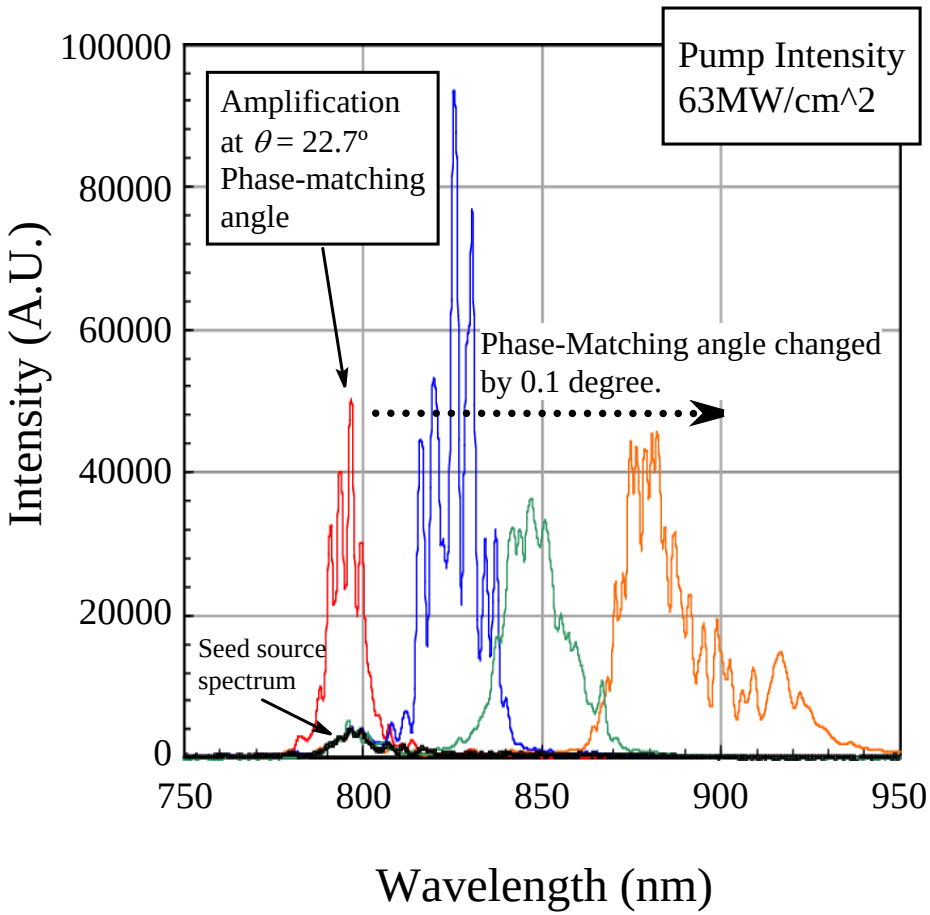
We amplified broadband seed source from 700mm PCF.

Spectrum of broadband amplification



We amplified broadband seed source from 700mm PCF.

Tunability of amplified spectrum



The results are

- Amplification range over 100nm FWHM
- Amplification tuning range 800 - 900nm.

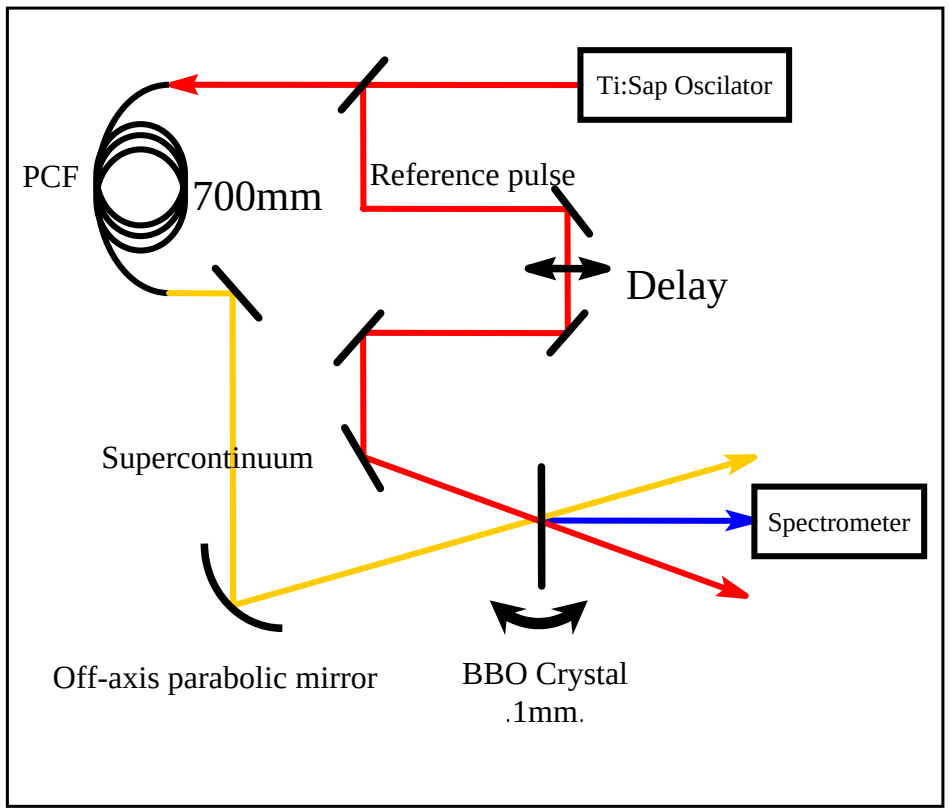
But, those spectrum have microstructure.

Microstructure have an effect on pulse compression.

Supercontinuum measurement

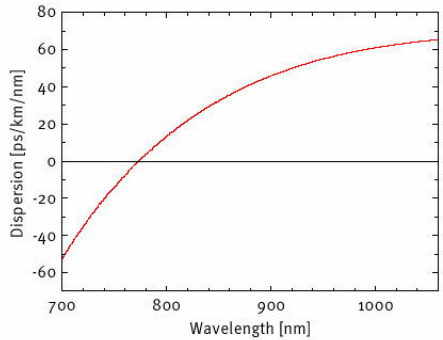
Experimental setup

Seed source : 800nm 100fs 80MHz 7.2mW

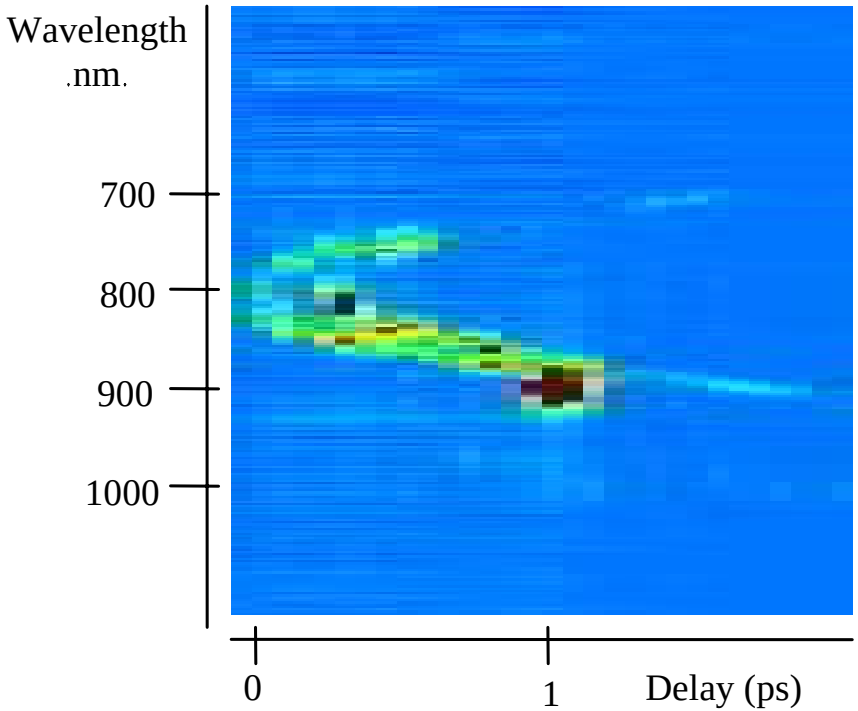


Dispersion of PCF

Zero dispersion
770nm

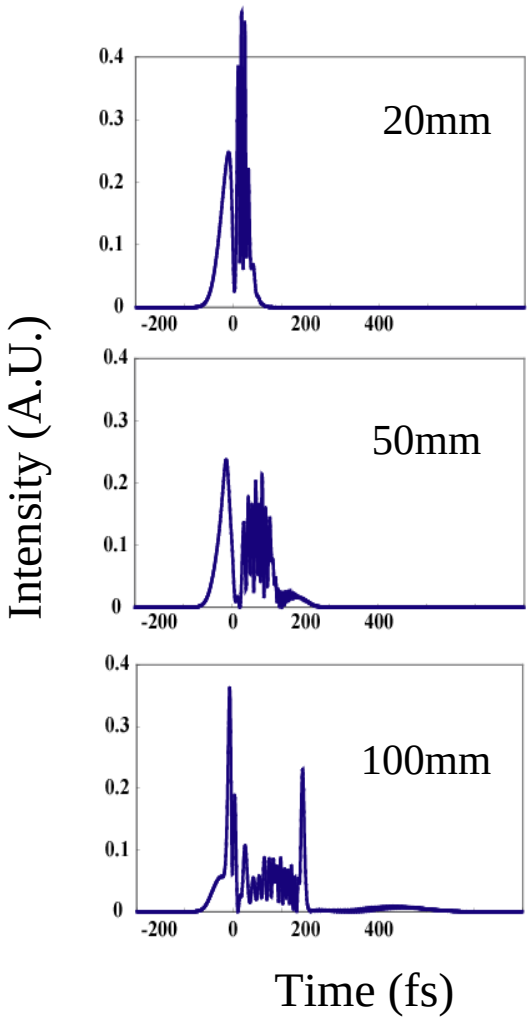


Spectrum of the supercontinuum

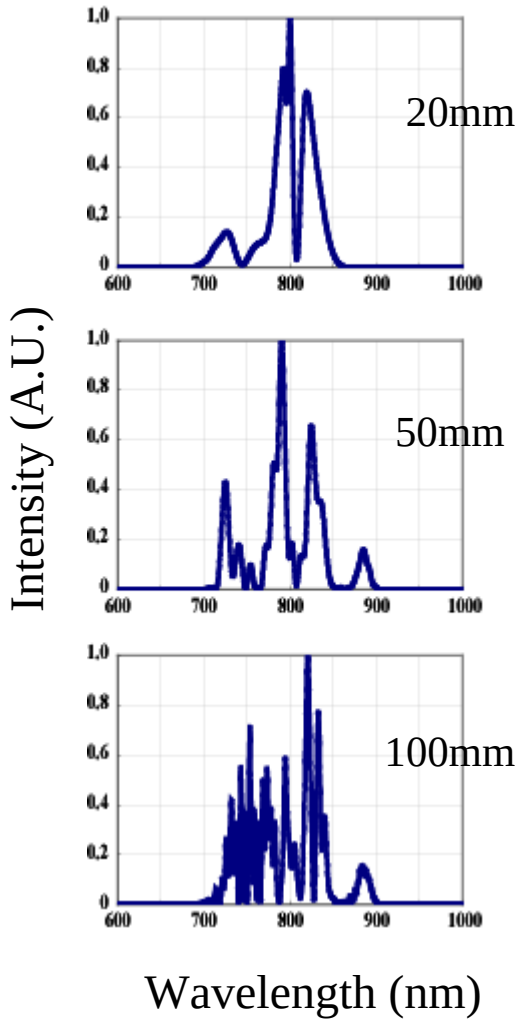


Simulation for supercontinuum generation

Dispersion by propagation (25mW)



Broadening by propagation (25mW)

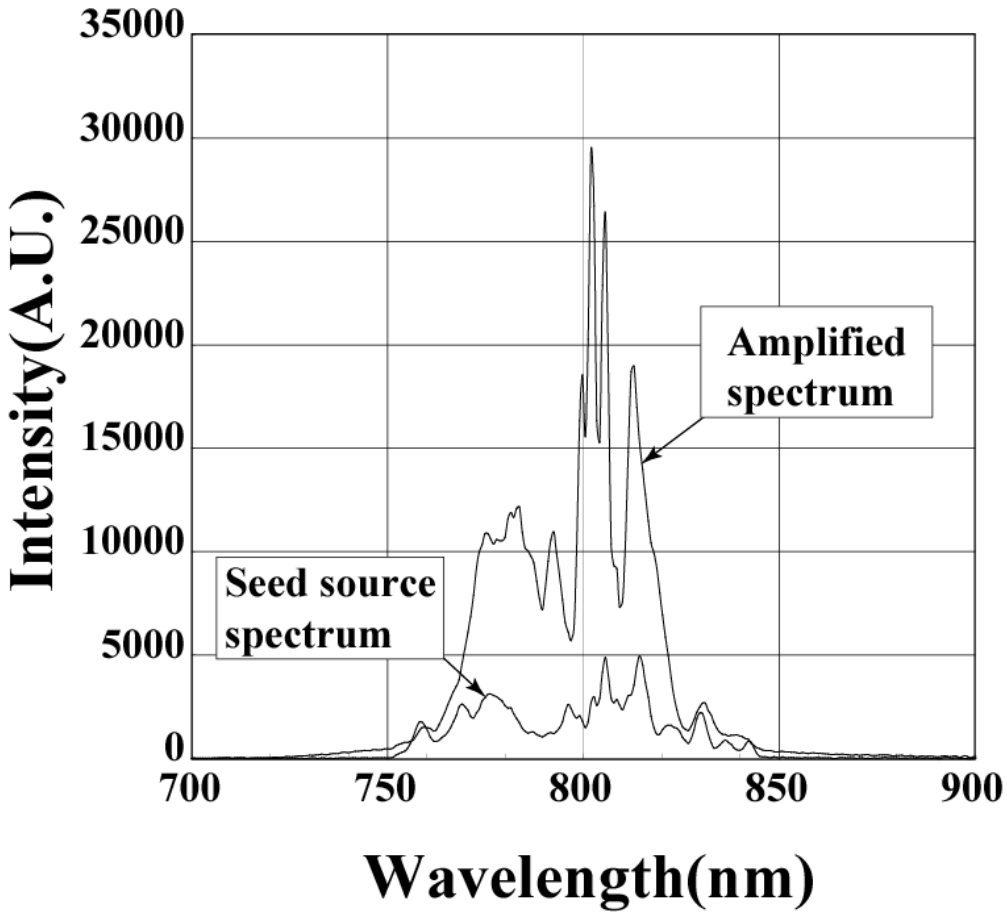


We calculated Nonlinear Schrodinger equation.

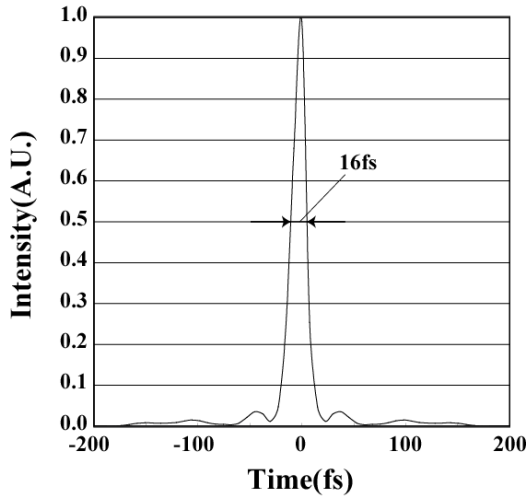
Shorter length of fiber is preferable for obtaining smooth spectrum.

Fiber length of 22mm was sufficient to generate broadband pulse.

Amplified spectrum



TL pulse



If we assume a flat phase distribution, transform limited pulse is calculated to be 16fs pulse.

Summary

. We have performed basic experiments for tunable femtosecond high-repetition laser.

・Generation of supercontinuum and amplification

··· Achieved amplification over 100nm

→ ・Tunability ··· Amplification range over 800 - 900nm.

・Specrum smoothing ··· Short fiber is effective.

○ Future work

・Phase control and pulse compression.

→

・Amplification by higher energy pump source.

··· We will complete 10TW OPCPA system.